

CLAIMS:

1 1. A method of determining at least one characteristic of an earth formation
2 surrounding a borehole using a rotating logging tool, the logging tool having at least one
3 emitter for emitting energy into the earth formation and at least one detector for detecting
4 energy reflected from the earth formation, the method comprising:

5 detecting energy during a plurality of sample periods with the detector to produce a
6 plurality of samples corresponding to the sample periods, wherein the duration of each sample
7 period is shorter than one half of the time required for the tool to complete a rotation;

8 measuring the azimuthal angle of the detector in at least one sample period;

9 measuring the standoff of the detector from the wall of the borehole in at least one
10 sample period;

11 sorting the samples into groups, each group representative of the azimuthal sector of
12 the borehole from which the sample was detected;

13 within a group, mathematically weighting each of the samples according to standoff;

14 within a group, mathematically summing the weighted samples to achieve a weighted
15 sample total for a sector;

16 within a group, dividing the weighted sample total by the total duration of sample

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17 periods in the group to determine an detection rate for the sector; and
18 transforming the detection rate for at least one sector into a representation of at least
19 one formation characteristic.

1 2. The method of claim 1 further comprising transforming the detection rate for
2 at least two of the sectors into the same formation characteristic to produce an image of the
3 borehole with respect to the particular formation characteristic.

1 3. The method of claim 1 further comprising transforming the detection rate for
2 one or more sectors into a representation of a representative formation characteristic of the
3 borehole.

1 4. The method of claim 1 wherein the emitter emits gamma radiation and the
2 detectors detect counts of back-scattered gamma radiation.

1 5. The method of claim 4 wherein the at least one formation characteristic
2 comprises density.

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1 6. The method of claim 4 wherein the at least one formation characteristic
2 comprises a lithology indicator.

1 7. The method of claim 1 wherein the borehole is divided into sixteen azimuthal
2 sectors.

1 8. The method of claim 1 further comprising deriving a representation of a
2 representative characteristic for at least two portions of the circumference of the borehole.

1 9. The method of claim 1 wherein the duration of each sample period is shorter
2 than the time that the detector is in the azimuthal sector in one rotation of the tool.

1 10. The method of claim 1 wherein the energy is detected in a first energy interval
2 and a second energy interval during the sample periods;
3 wherein the steps of mathematically weighting each of the samples according to
4 standoff, mathematically summing the weighted samples, and dividing the weighted sample
5 total by the total duration of the sample periods are performed with respect to the first energy
6 interval and then with respect to the second energy interval; and

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7 wherein transforming the detection rate for at least one sector comprises transforming
8 the detection rate for at least one energy interval for at least one sector into a representation
9 of at least one formation characteristic.

1 11. A method of determining at least one characteristic of an earth formation
2 surrounding a borehole using a rotating logging tool, the logging tool having at least one
3 emitter for emitting energy into the earth formation and at least one detector for detecting
4 energy reflected from the earth formation, comprising:

5 detecting energy during a plurality of sample periods with the detector to produce a
6 plurality of samples corresponding with the sample periods, wherein the duration of each
7 sample period is shorter than one half of the time required for the tool to complete a rotation;

8 measuring the azimuthal angle of the detector in at least one sample period;

9 sorting the samples into a plurality of groups, each group representing the azimuthal
10 sector of the borehole from which each sample was detected;

11 within a group, calculating the mean of the samples;

12 within a group, calculating a theoretical standard deviation of the samples;

13 within a group, calculating an actual standard deviation of the samples;

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14 within a group, mathematically weighting each of the samples according to the
15 deviation of the sample from the mean and mathematically summing the weighted samples to
16 produce a weighted sample total for a sector;

17 within a group, dividing the weighted sample total by the total duration of sample
18 periods in the group to determine an detection rate for the sector; and

19 transforming the detection rate for at least one sector into a representation of at least
20 one formation characteristic.

1 12. The method of claim 11 further comprising:

2 within a group, if the ratio of the actual standard deviation to the theoretical standard
3 deviation is below a given value, mathematically summing the samples to achieve a sample
4 total for a sector; and

5 within a group, dividing the weighted sample total by the total duration of sample
6 periods in the group to determine a count rate for the sector.

1 13. The method of claim 11 further comprising transforming the detection rate for
2 at least two of the sectors into the same formation characteristic to produce an image of the
3 borehole with respect to the formation characteristic.

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1 14. The method of claim 11 further comprising transforming the detection rate for
2 one or more sectors into a representative formation characteristic of the borehole.

1 15. The method of claim 11 wherein the emitter emits gamma radiation and the
2 detectors detect counts of back-scattered gamma radiation.

1 16. The method of claim 15 wherein the at least one formation characteristic
2 comprises density.

1 17. The method of claim 15 wherein the at least one formation characteristic
2 comprises a lithology indicator.

1 18. The method of claim 11 wherein the step of sorting the samples into a plurality
2 of groups comprises sorting the samples into sixteen groups.

1 19. The method of claim 11 wherein the duration of each sample period is shorter
2 than the time that the detector is in the azimuthal sector in one rotation of the tool.

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1 20. The method of claim 11 wherein the energy is detected in a first energy
2 interval and a second energy interval during the sample periods;

3 wherein the steps of mathematically weighting each of the samples according to
4 standoff, mathematically summing the weighted samples, and dividing the weighted sample
5 total by the total duration of the sample periods are performed with respect to the first energy
6 interval and then with respect to the second energy interval; and

7 wherein transforming the detection rate for at least one sector comprises transforming
8 the detection rate for at least one energy interval for at least one sector into a representation
9 of at least one formation characteristic.